E42.123

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY

FOREST INSECT INVESTIGATIONS

Notes on the Emergence and Sex Ratio of the Attacking Parent Adults of *Dendroctonus monticolae* in White Pine

1930

by
Donald DeLeon
Assistant Entomologist

Forest Insect Field Station,
Coeur d'Alene, Idaho,
November 20, 1930.

U. S. GOVERNMENT PRINTING OFFICE: 1935 J 76123

Notes on the Emergence and Sex Ratio of the Attacking Parent Adults of *Dendroctonus monticolae* in White Pine

1930

by
Donald DeLeon
Assistant Entomologist

Forest Insect Field Station,
Coeur d'Alene, Idaho,
November 20, 1930.

Notes on the Emergence and Sex Ratio of the Attacking Parent Adults of *Dendroctonus monticolae* in White Pine

INTRODUCTION

While the development of an epidemic is no doubt chiefly due to the multiplication of the progeny of the mountain pine beetle, brood multiplication does not appear to be the only factor. For many years workers of this Department have recognized the habit that the parent mountain pine beetles often show by leaving a tree the same season it was attacked.* This emergence has been ascribed to overcrowding, which was considered an abnormal condition, but it is believed now from the results of the study made the past season that though it may be due to overcrowding this emergence is a rather general occurrence. This habit is believed to be of considerable importance in the building up of an epidemic, as will be shown below.

The data to follow are the results of a study conducted the past field season (1930) incidental to the regular study that was being conducted on the parasites and predators of the mountain pine beetle in white pine. The project was maintained near Sullivan Lake, Wn., on the Kaniksu National Forest. It should be born in mind that

* L.T.Simpson in two papers in the Canadian Entomologist for July and Dec. 1929 shows that this is a habit with Polygraphus rufipennis and *Dendroctonus simplex*. J.M.Swaine in the introduction to the first paper states that this is also a habit with *D. piceaperda*, *Ips perturbatus*, and *I. borealis*.

these data pertain to the region of Sullivan Lake, and that before they can be accepted conclusively must be checked with studies conducted in other regions. It was also pointed out to the writer that as the last two seasons have been unusually long the conditions described below may not be as regular as the data would indicate. However, it is felt that the developments are sufficiently important to warrant their being brought to the attention of other workers.

The photographs were made by Mr. E. J. Post, who also gave me much valuable assistance and advice.

PARENT BEETLE EMERGENCE

In the region of Sullivan Lake the mountain pine beetle brood was found to overwinter in three overlapping degrees of development. In April many trees were found to contain almost entirely immature adults, with but relatively few mature larvae; other trees were found to contain chiefly mature larvae and but few callow adults; while still other trees contained only half-grown larvae. As no living pupae were found in the spring, the brood apparently can not overwinter successfully in that stage.* It was first thought that the trees which held the two broods of lesser age represented attacks by brood which had completed one and perhaps one and a half complete generations the previous summer. Such, however,

* This will be brought out in a report by Mr. A. L. Gibson, who has established this rather conclusively.

did not appear to be the case in the light of further examinations. The area in which the observations were made was cruised rather regularly and thoroughly for new attacks. In this region but one tree was found which was attacked during June. This was undoubtedly attacked by the emerged beetles of some of the brood that had been overwintering as callow adults, but the vast majority of the immature beetles apparently remained under the bark until early July, by which time most of the overwintering brood of the other two ages had caught up in development with the callow beetles.

The first general attack began between July 9 and 11, but attacks continued steadily to September 5. Each tree as it was attacked was numbered, and a basal area entirely around the tree and to a height of about 5 feet was marked off on 30 trees and examined every other day, when possible, for emergence holes. Each hole was marked with crayon so that there would be no chance of recounting the holes. Plate 1, Figures 1 and 2, give some idea of the number of emergence holes.

Table 1a below summarizes the data on the 30 trees on which the parent beetle emergence counts were made.

Table 1a

Tree #	Date of Attack	Parent Beetle Emergence over 10-day periods: Aug. 1-10	Aug. 11-20	Aug. 21-30	Sept. 1-10	Sept. 11-20	Sept. 21-30	Total # Exit Holes	Total Exit Holes per Sq. Ft.	Sq. Ft. Examined
2	July 9	169	45	13	21	1	0	249	28	9
21	21	0	256	71	32	0	0	359	16	23
22	24	0	32	211	78	6	0	327	10	32
23	24	0	27	176	126	7	0	336	11	30
24	24	0	63	115	50	5	4	237	9	26
25	25	0	6	74	49	3	1	133	6	21
26	25	0	2	58	47	0	0	107	5	21
27	27	2	14	66	45	3	0	130	9	14
28	28	0	27	194	100	10	0	331	13	26
29	31	0	4	153	110	17	1	285	12	24
30	31	0	7	191	139	14	4	355	13	27
31	31	0	6	333	227	22	2	590	21	28
32	31	0	1	38	113	14	1	167	9	18
33	31	0	0	151	98	9	3	261	13	20
34	31	0	5	108	70	14	1	198	11	18
42	31	0	3	154	132	22	2	313	13	23
43	Aug. 3	0	0	78	181	11	0	270	9	28
50	5	0	0	0	4	4	0	8	.4	20
51	5	0	0	18	87	5	2	112	6	18
57	5	0	0	11	252	37	9	309	9	35
54	8	0	0	2	1	3	0	6	.23	26
55	8	0	0	0	1	0	0	1	.03	29
60	15	---	0	0	3	5	1	9	.29	30
65	19	---	0	0	0	0	3	3	.2	19
66	23	---	---	0	0	0	1	1	.05	20
67	23	---	---	0	0	0	0	0		
68	23	---	---	0	0	0	0	0		
69	Sept. 2	---	---	---	0	0	0	0		
70	4	---	---	---	0	0	0	0		
71	4	---	---	---	0	0	0	0		

From the foregoing table it is seen that most of the parent beetle emergence occurred during the period between August 21 and September 10, and also that very few beetles emerged from trees attacked after August 5. The average emergence per square foot for the basal area of each tree attacked during July was between 10 and 15 holes. This figure, however, appears to be lower than the average for the entire tree.

Tree No. 1, attacked July 9 (on which no basal counts were made), and tree No. 28, attacked July 28, were felled September 17 and 19 respectively. One quarter square foot sample counts were made on the north, east, south, and west sides at 10 foot intervals for the infested length. These counts showed an average of 17 exit holes per sq. ft. for tree No. 1 and 16 exit holes per sq. ft. for tree No. 28. On tree No. 1 only one living beetle and no dead beetles were recorded for the entire tree; tree No. 28 had an average of two living and one dead beetle per sq. ft. Most of the living beetles in tree No. 28 were at the 90 and 110 ft. intervals, where the brood was still chiefly in the egg and small larval stage; in many cases the parent beetles had not yet finished constructing their galleries. This would indicate that this portion of the tree was filled in several weeks after the main attack on the tree had been completed.

The emergence of beetles from the attacked trees seems to occur in a definite manner. That is to say, emergence begins with a few beetles leaving the tree about 20 days after attack and only a few more leaving each succeeding day until suddenly a relatively great number emerge over a space of one or two days, and after that there is a fairly rapid tapering off of emergence. This is best shown by the accompanying graphs of the emergence from 19 trees. While the period of emergence begins about 20 days after attack there is a considerable variation from this time with many trees. The period from attack to peak of emergence, which is generally between 28 and 31 days, appears to be much more constant. This is shown in Table 1b below. An examination of the weather record for the period over which the emergence occurred does not indicate that variations in temperature and humidity are the factor.

Table 1b

Tree* No.	Date of Attack	Elapsed Time from Date of First Attack to First Exit Hole	Elapsed Time from Date of Attack to Peak of Emergence	Elapsed Time from First Exit Hole to Peak of Emergence	Number Emerged at Peak	Number Emerged First Time
		Days	Days	Days		
2	July 9	22	28	6	40	40
21	21	23	26	3	201	33
22	24	21	31	10	103	5
23	24	21	31	10	61	7
24	24	21	31	10	55	42
25	25	20	30	10	33	1
26	25	24	29	5	30	2
27	27	8	27	19	33	2
28	28	7	25	18	102	11
29	31	14	30	16	78	2
30	31	16	30	14	72	7
31	31	14	25	11	113	6
32	31	15	35	20	31	1
33	31	22	30	8	65	28
34	31	17	30	13	41	5
42	31	15	30	15	50	3
43	Aug. 3	20	30	10	59	7
51	5	18	31	13	29	1
57	5	14	31	17	57	4
	Average	17.5	29.5	12	66	11

One of the most important points, however, brought out by the first table (1a) is the long space of time over which the attacks occur. By July 11 trees attacked the previous season showed nearly complete emergence around the bases where the examinations were made; however, a few callow beetles were found in the same trees as late as September

* Trees with a total emergence of less than 10 are not recorded.

22. The one tree which was attacked in June showed no emergence August 18, but there was some brood emergence when next examined September 23. Nevertheless, from neither of these two sources does it seem possible that all of the attacks occurring during August could have arisen. It seems reasonable to assume that these later attacks were caused chiefly by the parent beetles which had emerged from the trees they first attacked. Map 1, following the charts at the end of the report, shows the position of many of the attacked trees and approximate time they were attacked. It is striking how the attacks have progressed. The trees represented by the circles in red and blue and part of the trees represented by the brown circles were no doubt attacked by the beetles of the general July emergence; i. e., the brood developed in trees attacked the previous season. But those represented by the green, yellow, and black circles and part of those represented by the brown circles were attacked for the most part, it is believed, by the parent beetles emerging from the July attacked trees.

As mentioned above, trees attacked after August 8 showed practically no parent beetle emergence. This may be due to several factors: (1) if as we believe practically all of the trees attacked in August are attacked by emerged parent adults, then by the time the parent beetles have completed their second set of galleries their vitality for constructing more tunnels and their capability of laying more eggs may be lowered to such an extent that they are unable or lack the urge to leave the tree to construct a third set

of galleries; (2) the general lowering of the daily temperature may slow down beetle activity so that they are not able to complete their second set of galleries if they are parent beetles, or first set of galleries if but first brood, before cold weather sets in; and (3) perhaps it is an inherent characteristic to emerge and reattack but once. Simpson (Loc. cit.), however, has found that D. simplex will emerge twice and reattack three times. In a very long season this may also be the case with the mountain pine beetle.

SEX RATIO IN THE EGG GALLERIES

In making the counts each one of the exit holes was considered to represent the emergence from one gallery. In a few cases, however, two exit holes are constructed for a single gallery; the male and female beetles apparently emerging separately. Hitherto two beetles (a male and female) were always considered as inhabiting one gallery. However, it was found that only about 57 per cent of the galleries contained two beetles. The remaining 43 per cent of the galleries are inhabited by the female alone. See Table 4 below.

Whether there is an actual preponderance of females or whether there is about an equal proportion of males and females but not all the males enter the galleries has not yet been determined. Gibson and Hunt in 1927 on a lodgepole pine observed a male beetle copulate with a female at the entrance of the egg gallery. The male after copulation wandered off, inspected other galleries, and finally apparently tried to induce another insect to copulate. This would indicate the reason why not all galleries contain both a male and female beetle.

Table 4
Showing Relative No. of Males
and Females per Gallery

Date of Attack	Date of Examination	No. Sq.Ft. Examined	Galleries Containing: Male and Female	Galleries Containing: Female only	Total Galleries Examined	Per Cent Galleries with Females only	Empty Galleries
July 17	July 25	11	148	116	271	43.9*	7
17	Aug. 6	1.25	12	9	27	42.8*	6

It is obvious that with a number of beetles sufficient to kill 100 trees by the previous reckoning of two beetles to an attack there will be killed instead about 143 trees. Then with a practically complete reemergence (if the attack occurs in July) there will be say 100 more trees attacked, deducting about 43 trees for flight mortality and the parent beetles that do not emerge. Thus, instead of 100 trees being attacked in one season by the given number of beetles, there will be 243 attacked trees -- an increase of 143 per cent.

These habits, if normal, which never before have been seriously considered in figuring the increase of an infestation, must have a great deal to do with the rapid building up or an infestation, and as brood increase alone does not entirely account for the sudden rises of epidemics these habits may be normal, or perhaps these habits may occur at varying periods and be the chief cause for the building up of an infestation. This last possibility does not seem plausible, however.

* The empty galleries were not figured in when the percentages were computed, as the number of beetles which occupied the empty galleries could in no way be determined.

Still another element enters into the habit of parent beetles to emerge. Many spotters are confused by the beetle exit holes and mistake them for brood emergence holes. For by one not well acquainted with the beetle's habits this is easily done when one sees 10-15 or more exit holes to the square foot. See Plate 1. This error is furthered by the fact that the trees which show most of the exit holes are the trees which were attacked the earliest and are generally red-tops when the spotting has begun. Because of these two factors many trees which may contain heavy brood are apt to be passed up by the spotters as abondoned.

It is hoped that this report, chiefly because of its omissions, has shown the need for thorough study of these habits both in white pine and lodgepole pine.

EXPLANATION OF CHARTS

The charts show the number of emergence holes of parent Dendroctonus monticolae as they occurred in 19 of the 52 western white pine trees that were under observation. For example: On tree No. 2, 40 exit holes were counted August 1 (the date of the first examinations); August 2, 32 more holes were counted; these therefore were constructed between the time of examination on August 1 and 2; August 4, 24 more holes were counted, these being constructed between the time of examination on August 2 and 4; etc.

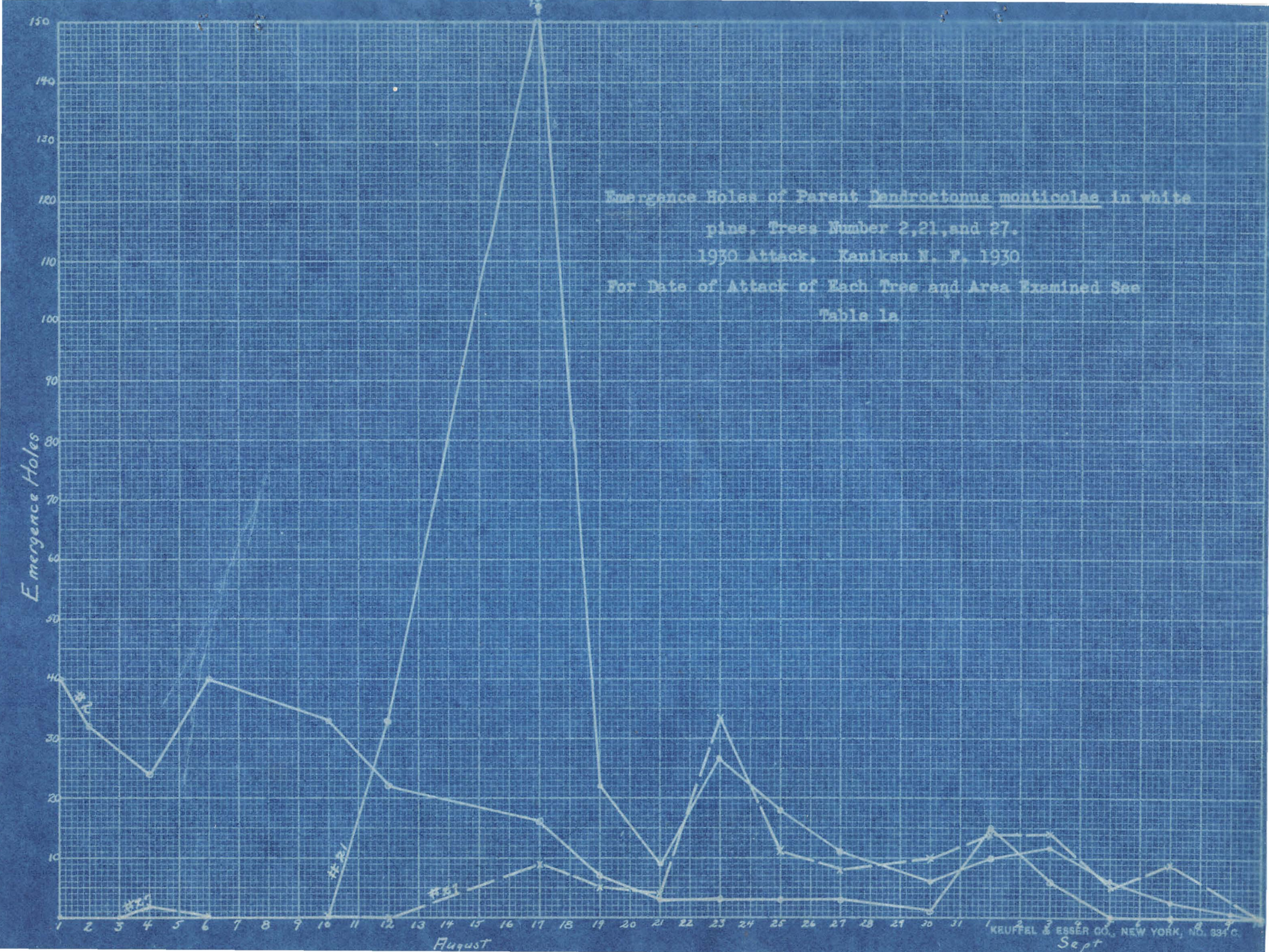
The final chart shows the maximum and minimum daily temperatures for the period of August 17 to September 23.

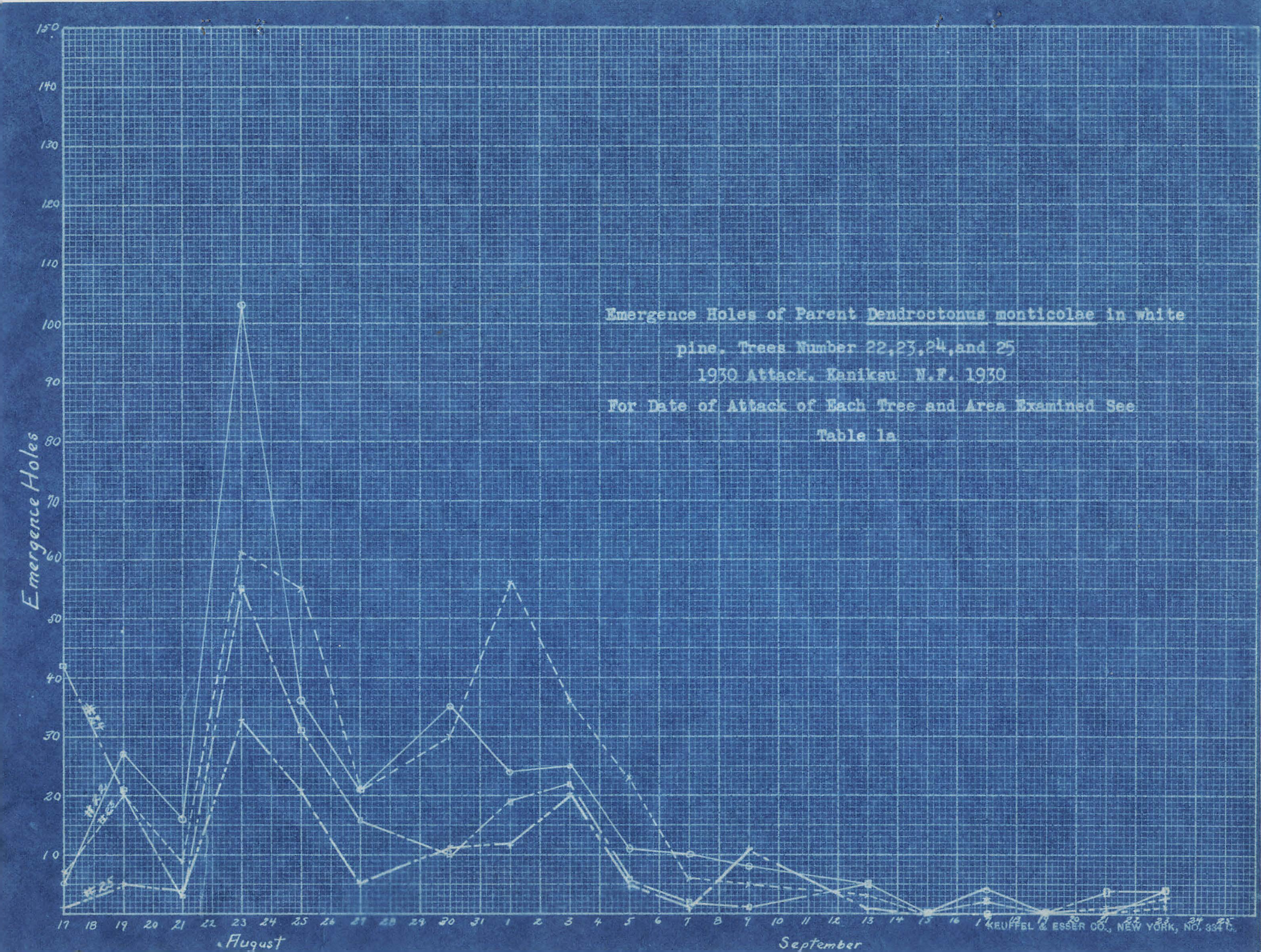
Plate I
Parent Dm Exit Holes in White Pine
Sullivan Lake, Wn.

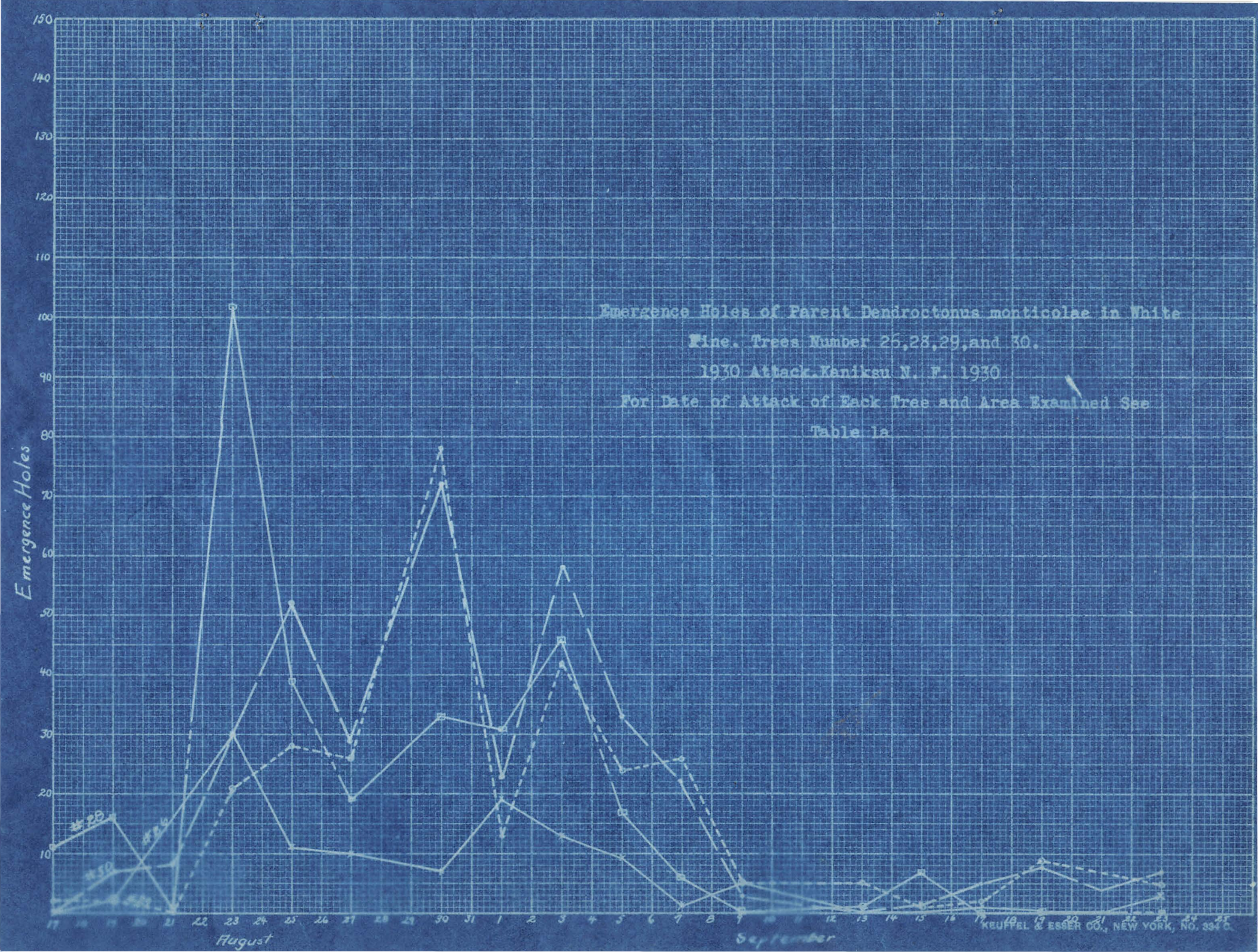
Fig. 1

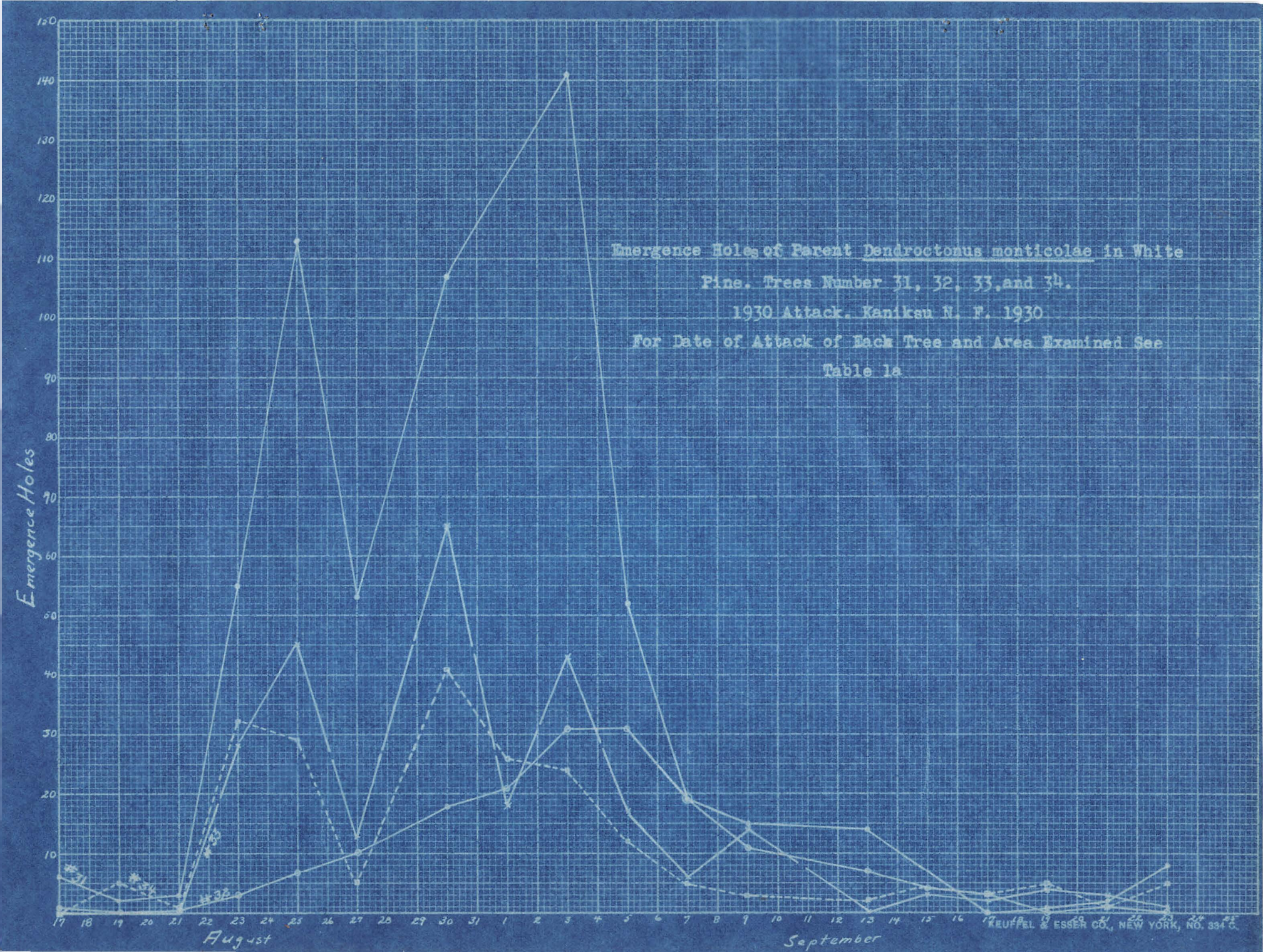
Fig. 2

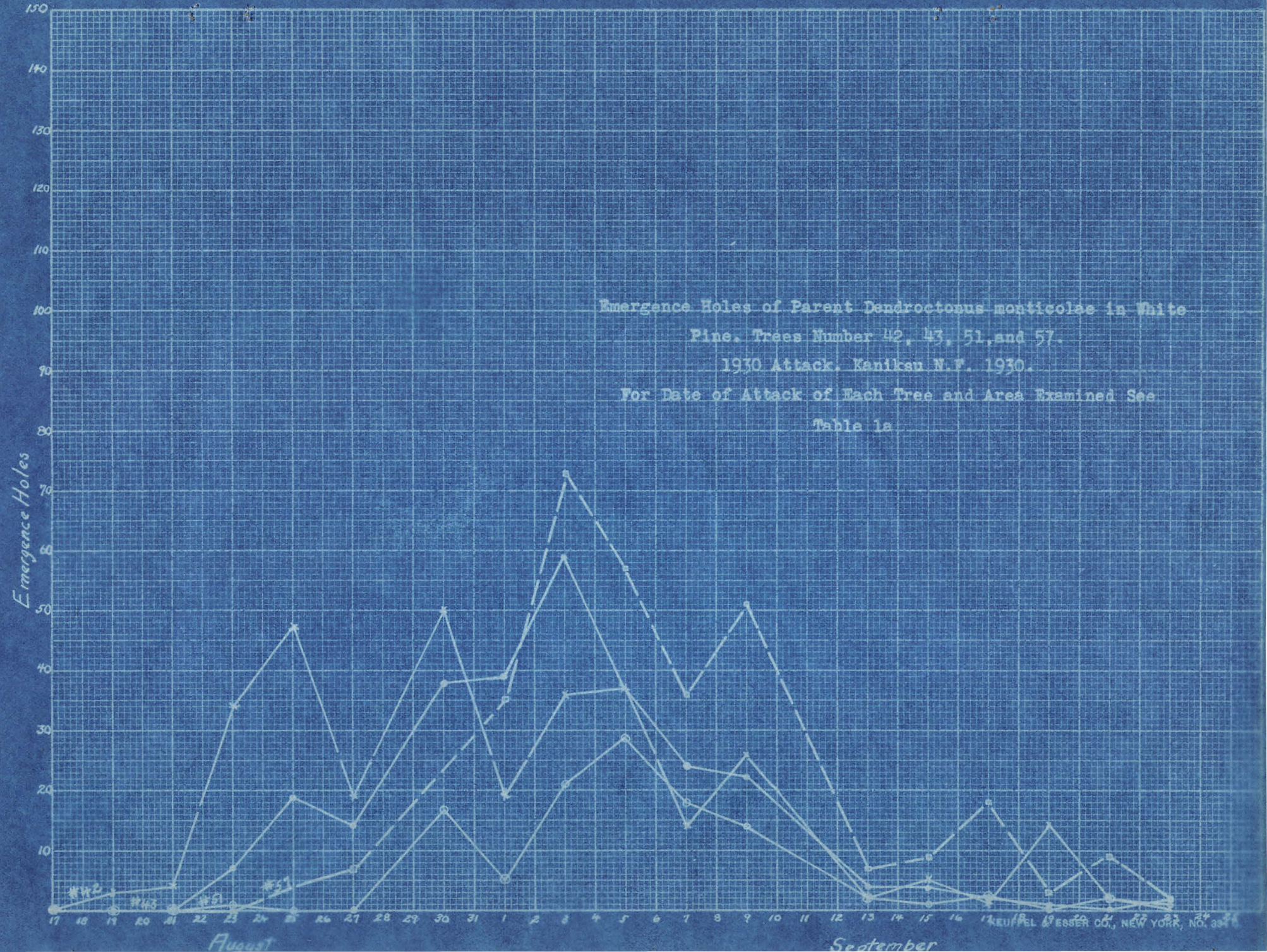
A match stick is inserted in each parent beetle exit hole.

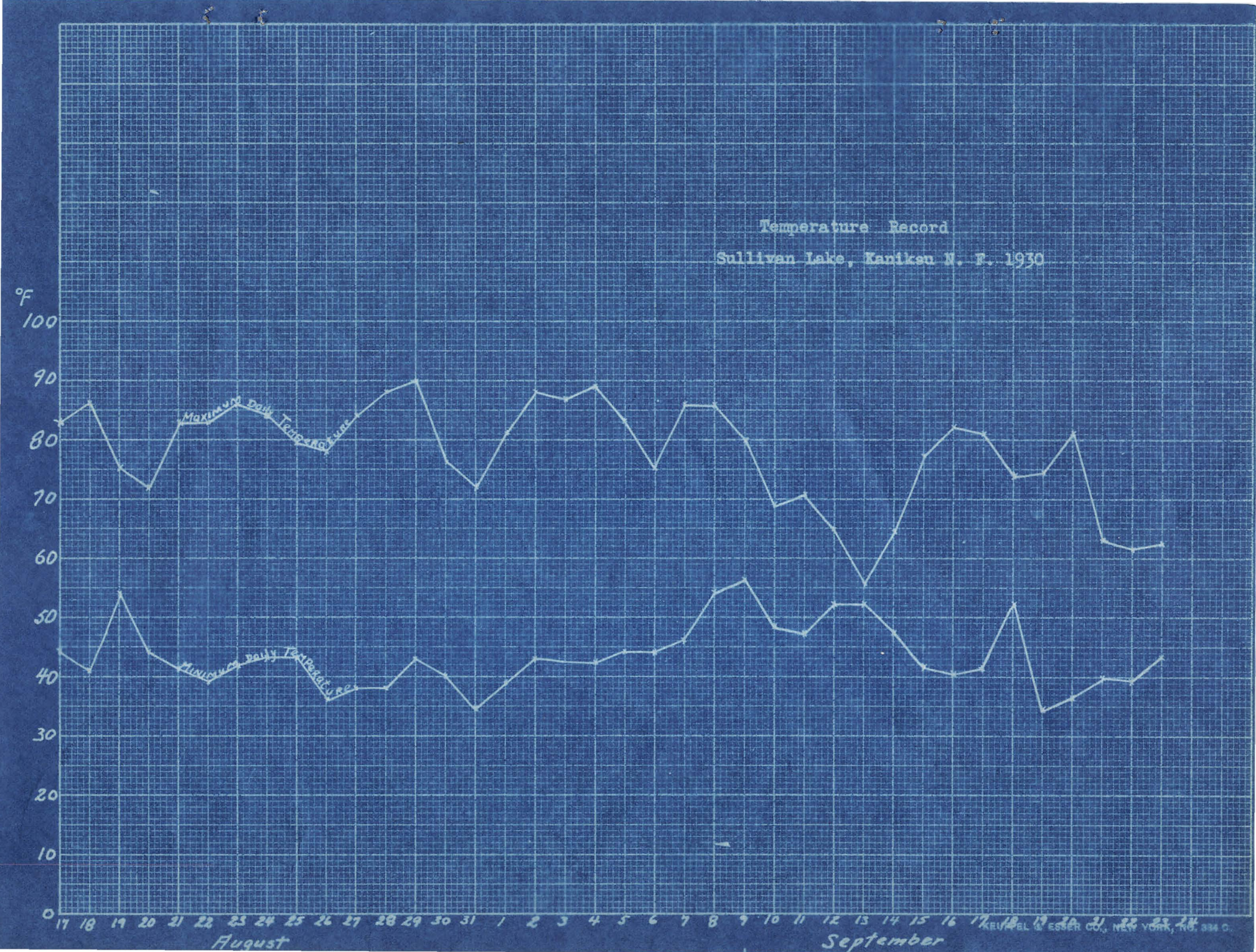

Emergence Holes of Parent Dendroctonus monticolae in white pine, Trees Number 2,21, and 27.
1930 Attack. Kaniksu N. F. 1930
For Date of Attack of Each Tree and Area Examined See Table 1a
Emergence Holes
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
#27
#21
#2
#21
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10
August
Sept
KRUFFEL & ESSER CO., NEW YORK, NO. 334 C.

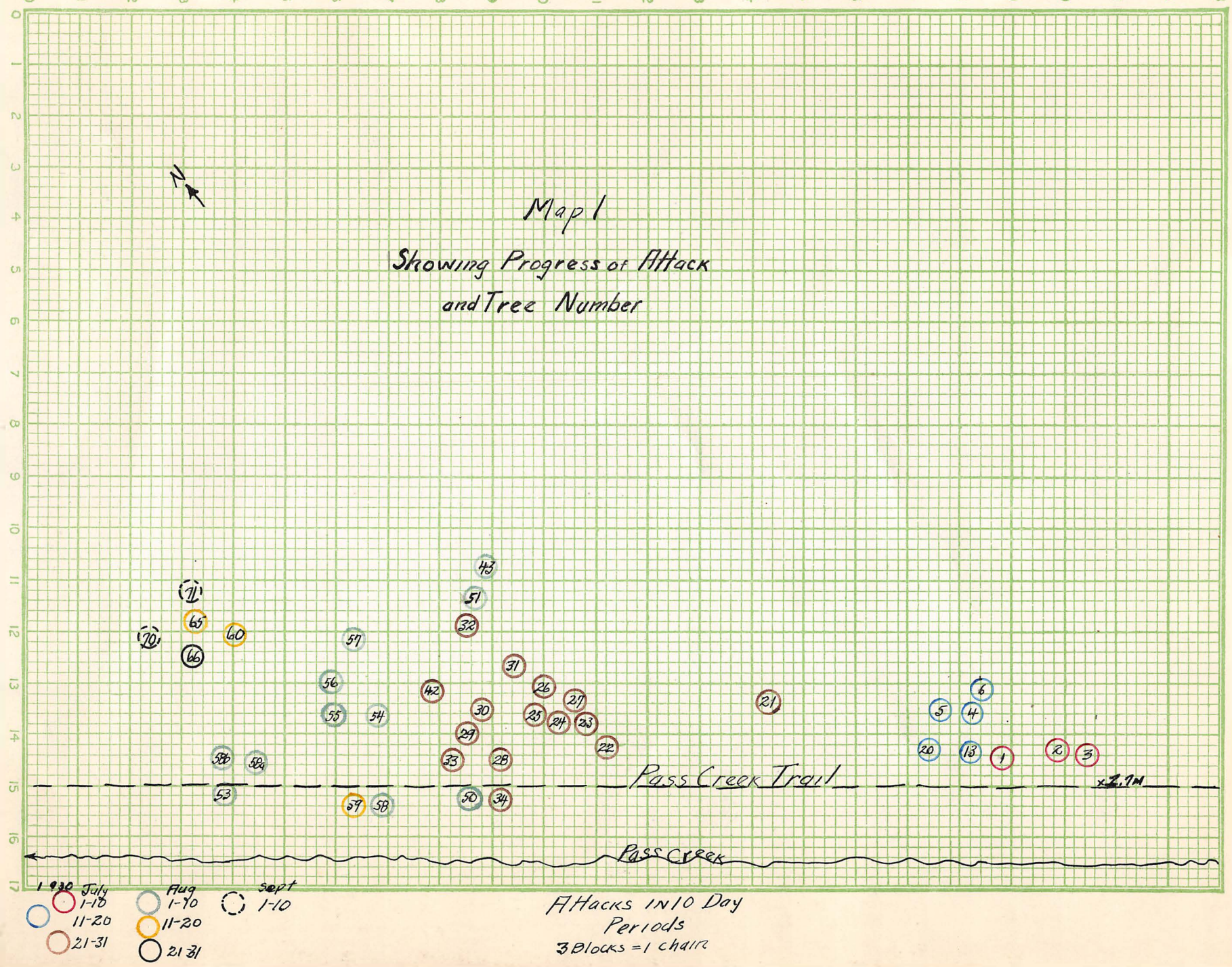

Emergence Holes of Parent Dendroctonus monticolae in white pine. Trees Number 22,23,24,and 25
1930 Attack. Kaniksu N.F. 1930
For Date of Attack of Each Tree and Area Examined See Table 1a
Emergence Holes
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
August
September
#22
#23
#24
#25
KEUFFEL & ESSER CO., NEW YORK, NO. 334 C.

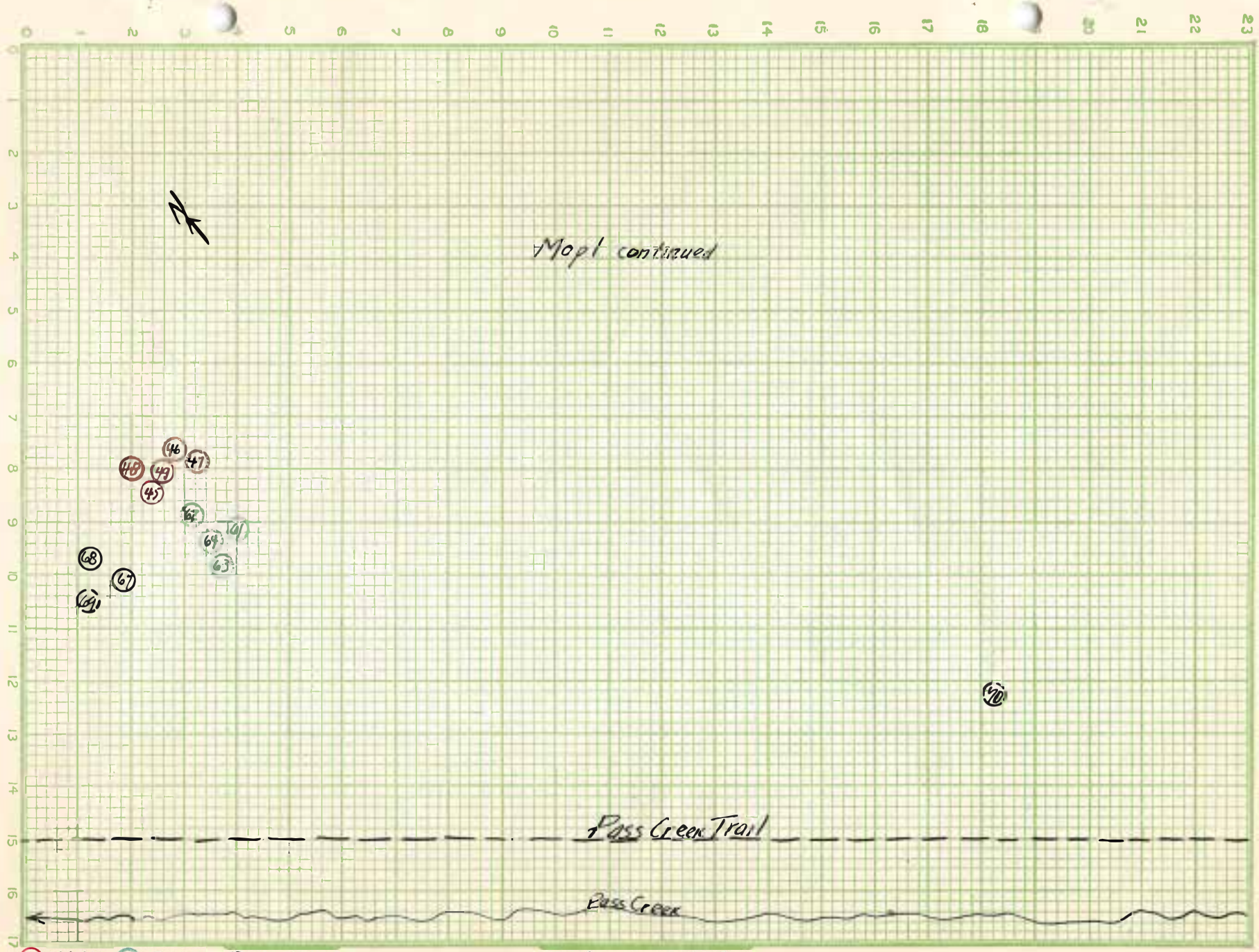

Emergence Holes of Parent Dendroctonus monticolae in White Pine. Trees Number 26,28,29,and 30.
1930 Attack. Kaniksu N. F. 1930
For Date of Attack of Each Tree and Area Examined See Table 1a
Emergence Holes
August
September
KEUFFEL & ESSER CO., NEW YORK, NO. 334 C.


Emergence Holes of Parent Dendroctonus monticolae in White Pine. Trees Number 31, 32, 33, and 34.
1930 Attack. Kaniksu N. F. 1930
For Date of Attack of Each Tree and Area Examined See Table 1a
Emergence Holes
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
August
September
#31
#34
#33
#32
KEUFFEL & ESSER CO., NEW YORK, NO. 334 C.


Emergence Holes of Parent Dendroctonus monticolae in White Pine. Trees Number 42, 43, 51, and 57.
1930 Attack. Kaniksu N.F. 1930.
For Date of Attack of Each Tree and Area Examined See Table 1a
Emergence Holes
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
#42
#43
#51
#57
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
August
September
KEUFFEL & ESSER CO., NEW YORK, NO. 339


Temperature Record
Sullivan Lake, Kaniksu N. F. 1930
°F
100
90
80
70
60
50
40
30
20
10
0
Maximum Daily Temperature
Minimum Daily Temperature
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
August
September
KEUFFEL & ESSER CO., NEW YORK, NO. 334 C.


N
Map 1
Showing Progress of Attack
and Tree Number
Pass Creek Trail
Pass Creek
x 2.7M
1930 July
1-10
11-20
21-31
Aug
1-10
11-20
21-31
Sept
1-10
Attacks in 10 Day
Periods
3 Blocks = 1 chain



July 1-10 ○ Aug 1-10 ○ Sept 1-10

○ 21-31 ○ 21-31

Attacks in 10 Day Periods

3 Blocks = 1 chain